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STRUCTURE of tree crops and agroforestry systems

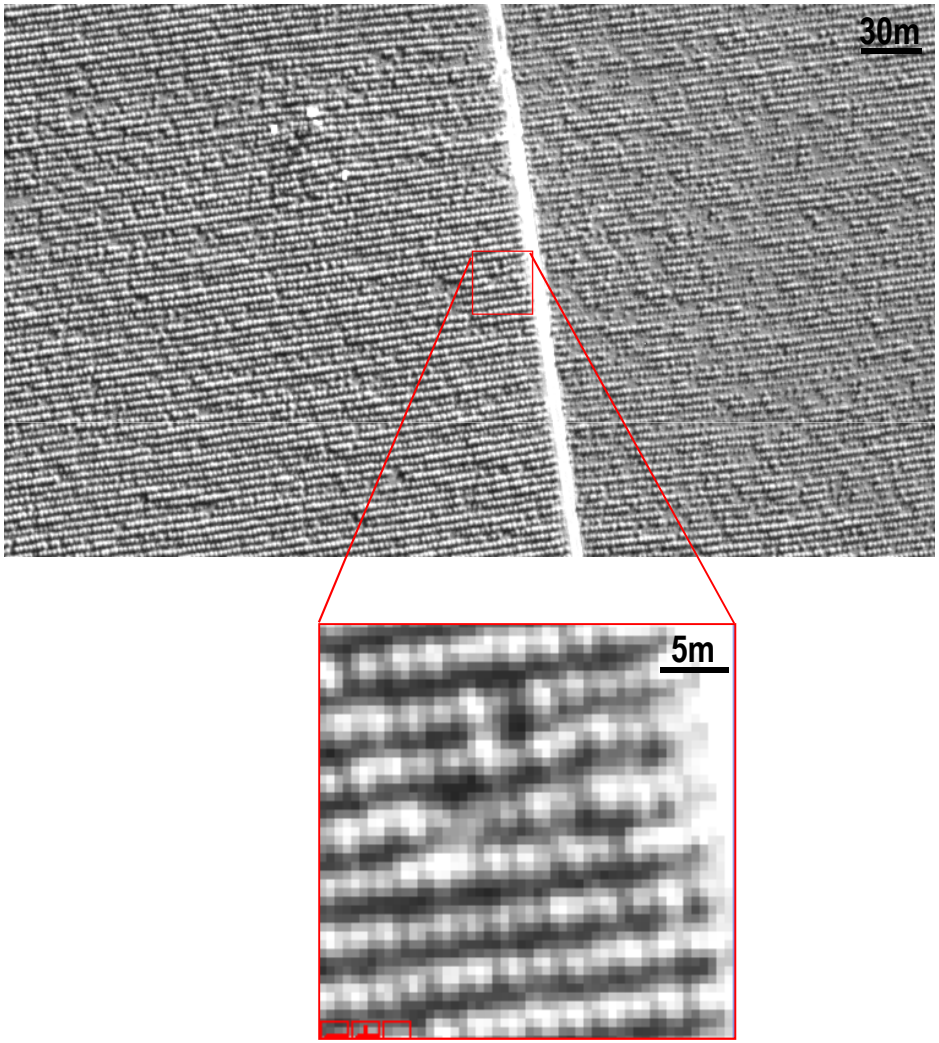
Camille LELONG, Guerric LE MAIRE
et al.

TETIS

ECO & SOLS

From monospecific tree crops

Eucalyptus plantations (Brazil)



Worldview -0.5 m

with various structures…

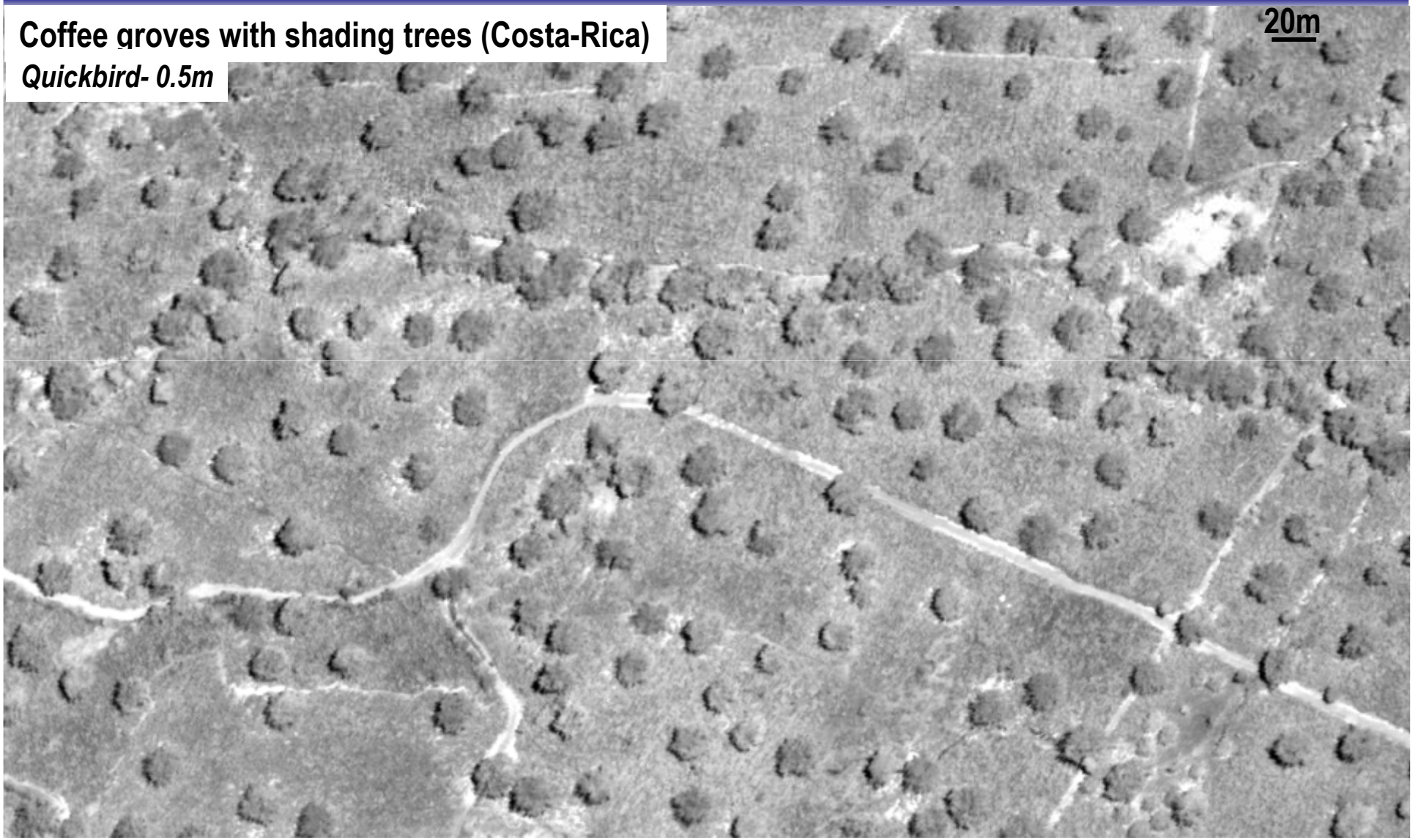
Fruit orchards, olive and vineyards (France)

Quickbird- 0.7m

…to diverse agroforestry systems

Association of trees of different species and trees with other crops

in a large range of complexity !



Cocoa-based agroforests (Cameroun)

Quickbird- 0.5m

Plot structure characterization

The intraplot structure analysis allows :

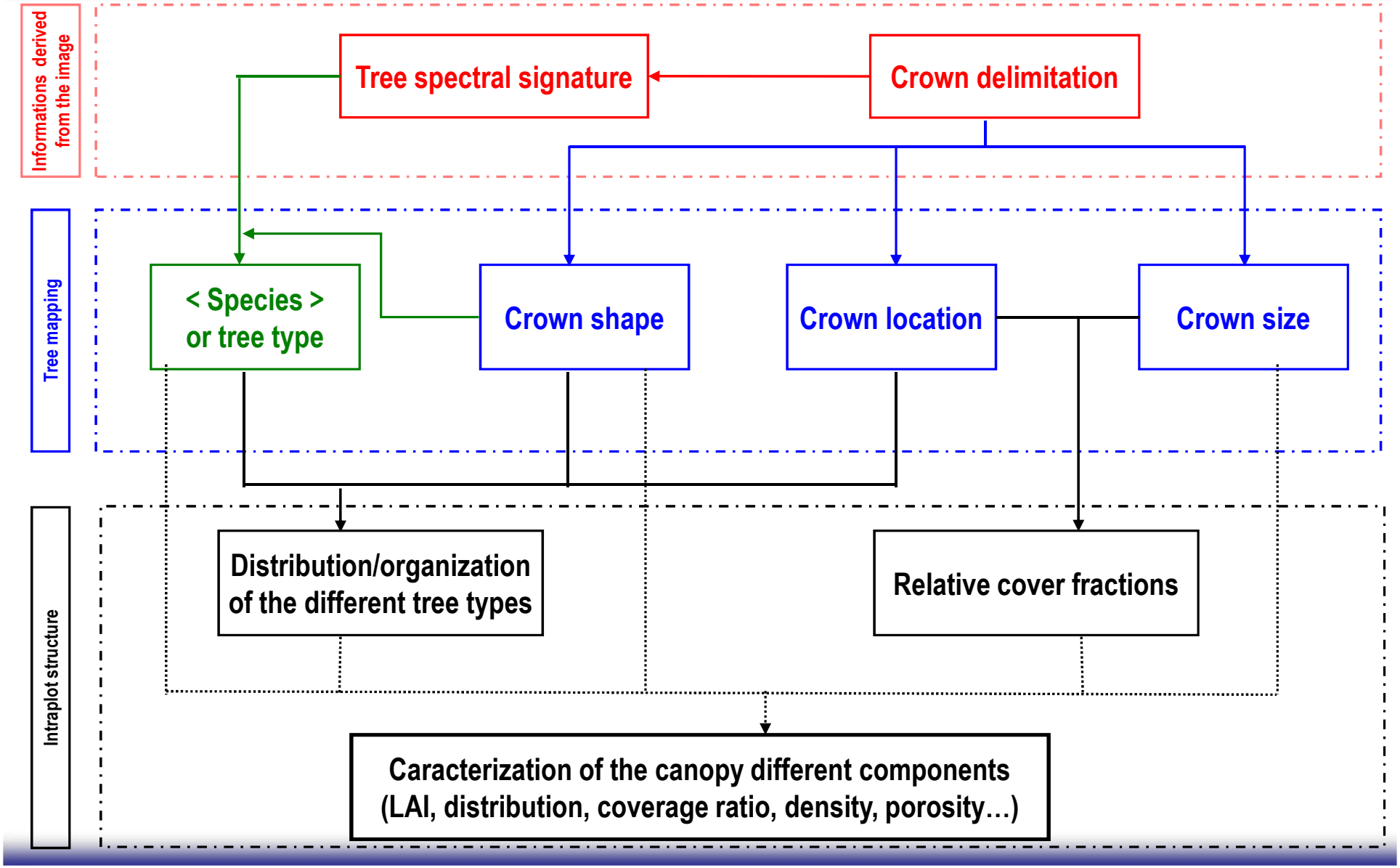
- identification and segmentation of tree plots
- classification of plantation types depending on their complexity level
- identification and inventory of the tree diversity
- biomass estimation, production evaluation
- characterization of the cropping system
- characterization of the biophysical status of the crop

In the aim of:

1. understanding the crop functionning
2. evaluating its agronomical potentials

↳VHSR remote sensing gives some tools to extract different indicators characterizing the intraplot structure of tree crops and agroforestry systems

Structure indicators estimation



Tree-crops accurate structure-based classification

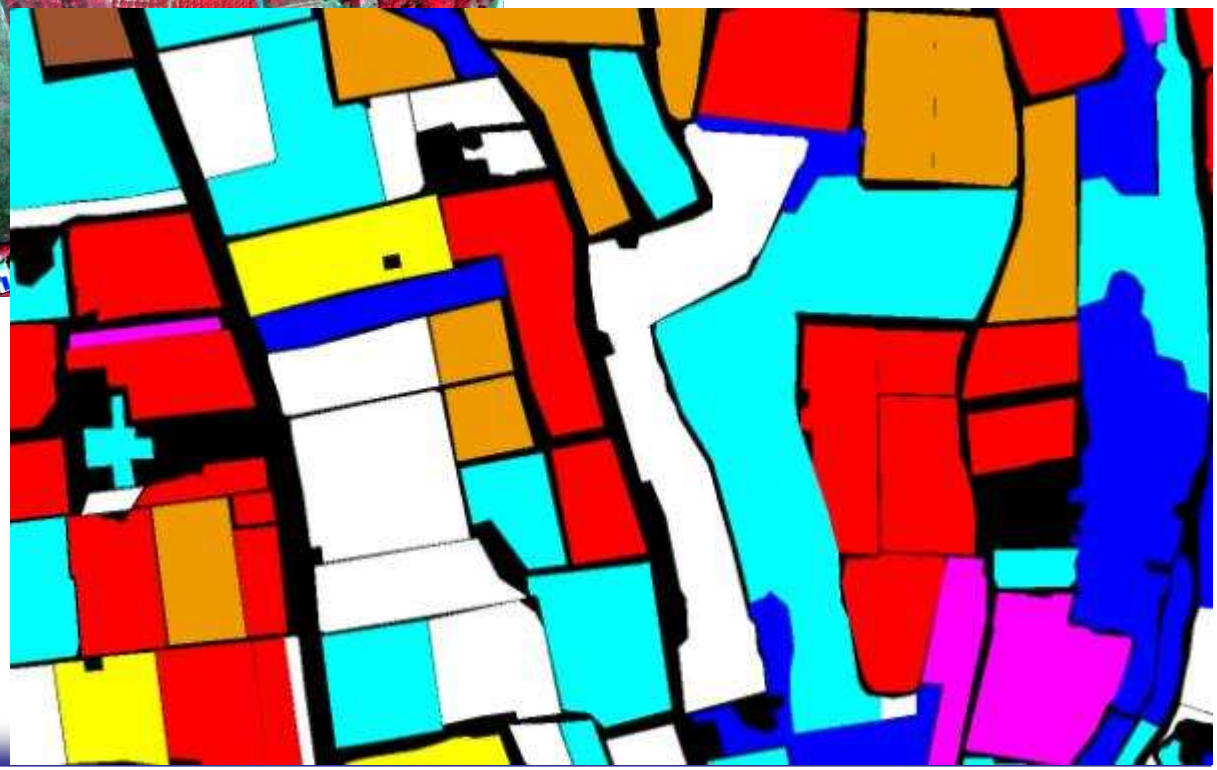
100m

Different types of orchards in the South of France

Tree-crops accurate structure-based classification

100m

- Cereals
- Vegetables
- Vineyards
- Apple groves (treillis)
- Old fruit grove (grid)
- Young fruit grove (grid)
- Fallow
- Forest



Different types of orchards in the South of France

Method: SVM classifier on Fourier parameters, texture indices, and NDVI

Intra-plot shading distribution

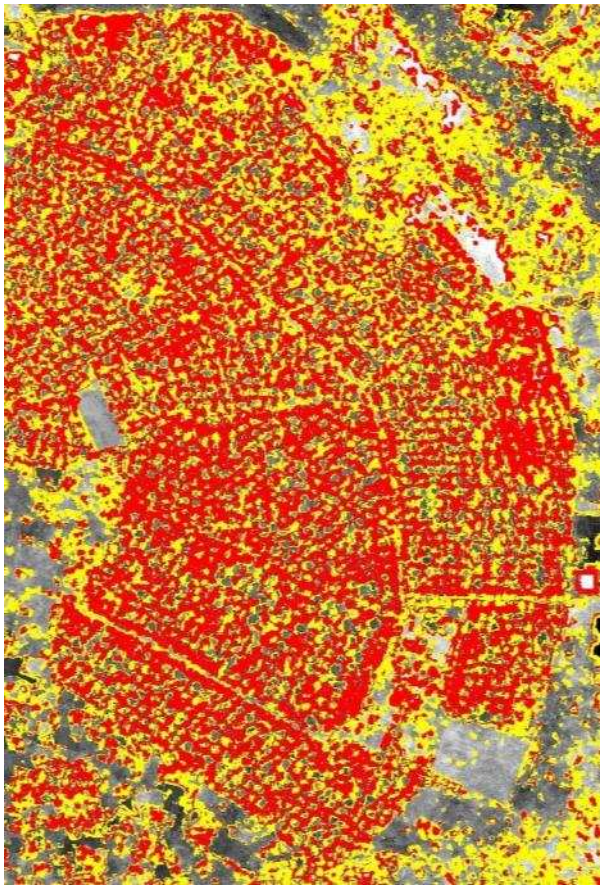
Method: multiscale textural analysis of panchro image

1. Ikonos image (1m/pix)

Shaded coffee plantation in Uganda

100m

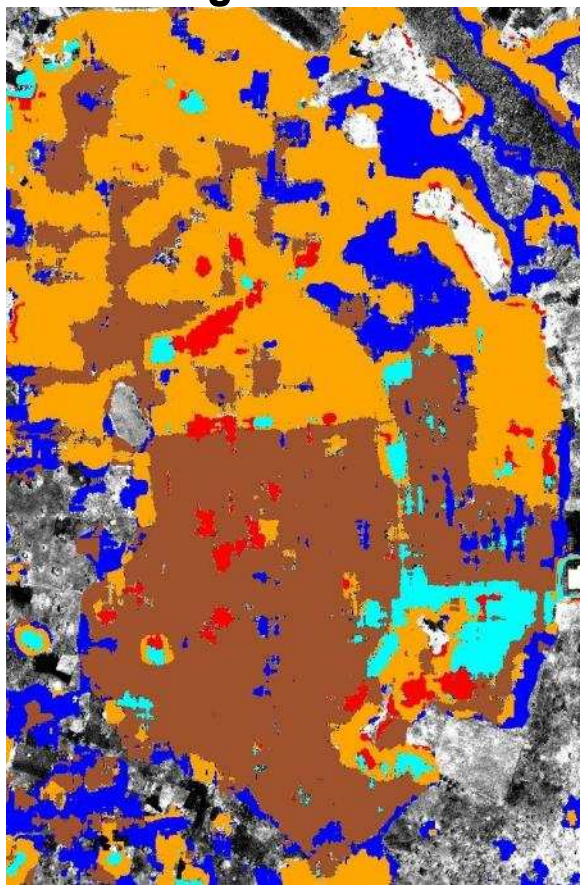
2- Tree identification



Coffee trees

Other trees

3- Shading-level estimation



Sunlight

Sparse shadow

Dense shadow

Other trees

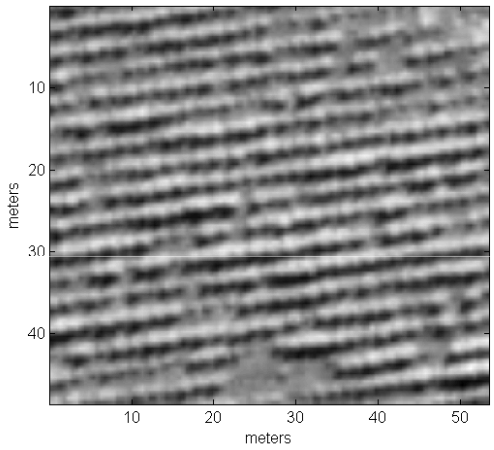
Crown delimitation

Eucalyptus plantations at early growth stages in Brazil

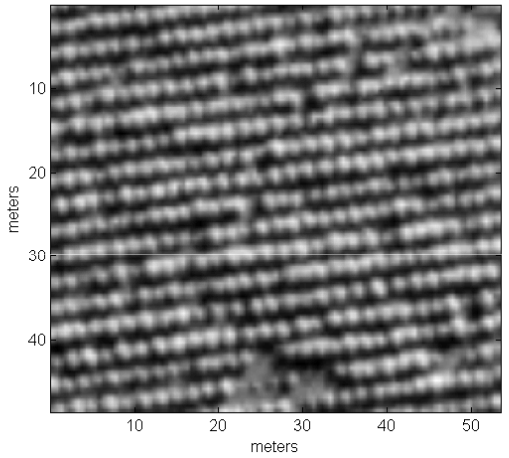
Method of detection: marked point processes (developed by INRIA)

a tree = a position (x,y) + a radius (r)

a study plot in May



in August



Crown delimitation

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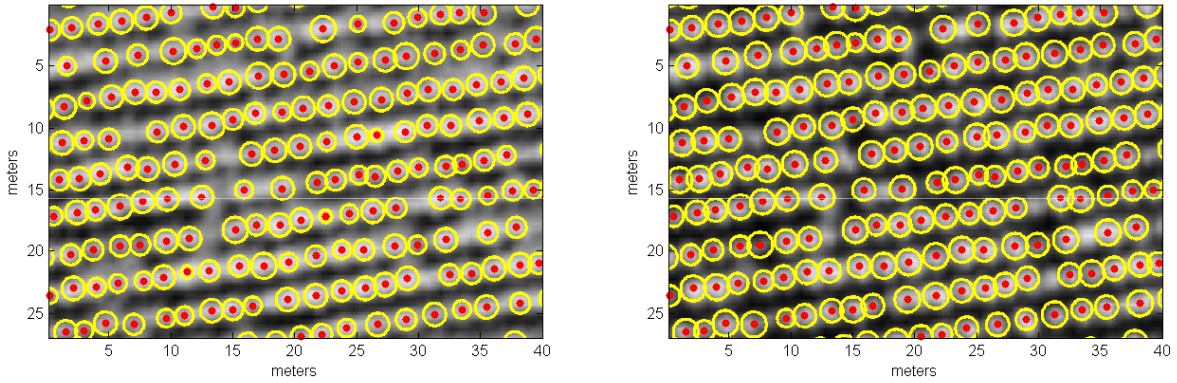


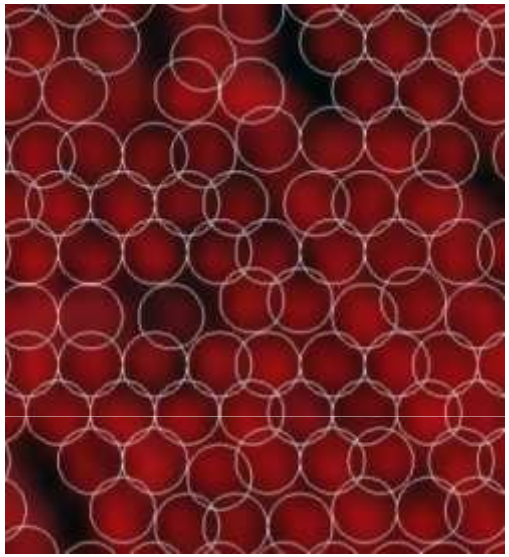
Results: comparison to field-measured positions and radius:

- good tree presence/absence detection: **93% of good detection**
- good position accuracy: **~70 cm precision**
- high uncertainty on radius estimations: **~70 cm (i.e. 30%)**

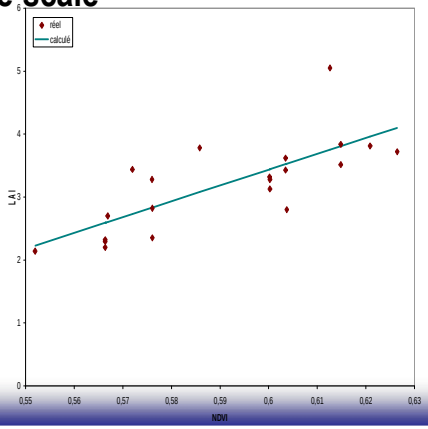
LAI at the tree scale

Oil palm estate in Indonesia

Oil palm trees (Quickbird)



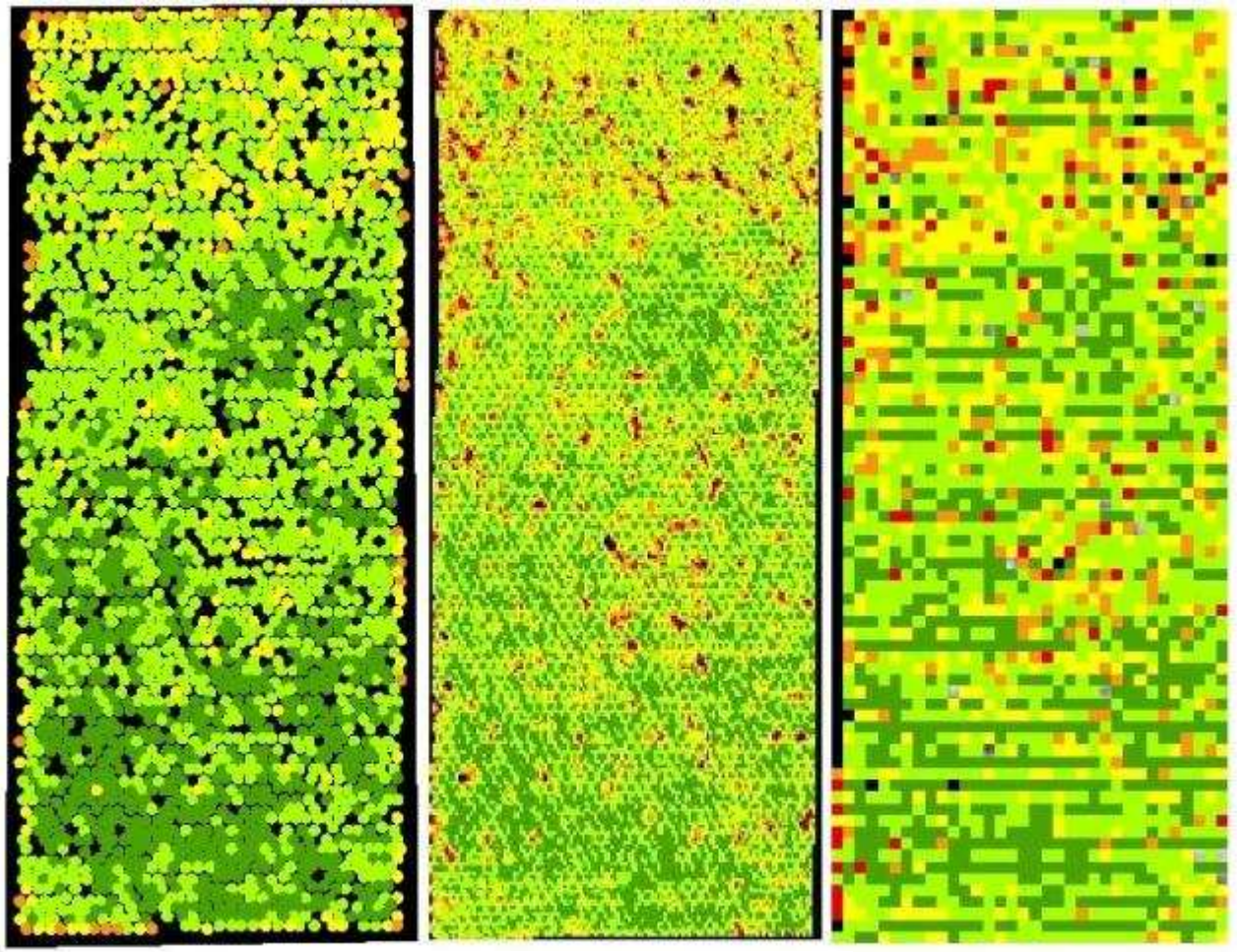
Calibration of LAI-NDVI relationship based on the field LAI measurements at tree scale



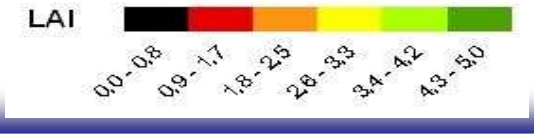
LAI of digitalized trees

2.5m-Pixel LAI

9m-Upscaled-pixel LAI

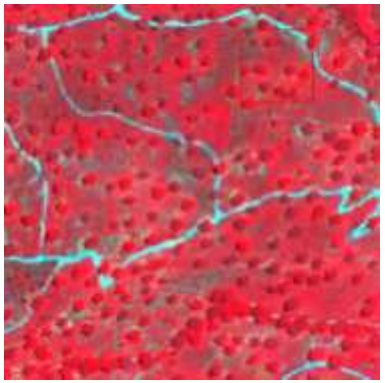


100m



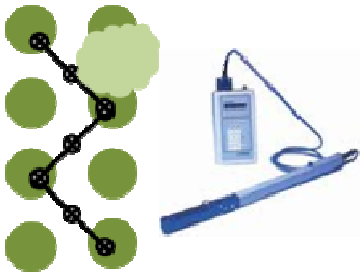
LAI of agroforestry systems

Coffee grove with shading trees in Costa-Rica



Worldview2-2m

①LAI Field measurements (LAI-2000 transects)



②Calibration of LAI-NDVI$_{HR}$ relationship based on the field measurements of transect values and NDVI distribution

$$LAI_{HR} = \max(0; \frac{-1.557}{\ln(NDVI_{HR})} - 2.778)$$

③Application of the LAI-NDVI$_{HR}$ relationship to the WV2 MS image

-resolution LAI map (RMSE=0.44)

High: 7

Low: 0

100m

Perspectives

- Integrate the maximum of information that could be included in the data, like using simultaneously radiometric and textural attributes.
- Test new directions for improving results and reach new indicators/products (eg. SVM, waveletts, ???)
- Give more generic power to the methods and tools
- Enlarge the range of applications to more complex agroforestry structures
- Integrate the products in functionning, understanding and characterization models of these systems, especially in the aim of evalutating their diverse products and services.

Contributors

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Coffee in Costa Rica

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